

PROJECT MANAGEMENT: AN OVERVIEW TO EFFECTIVE PROJECT MANAGEMENT



Sheet Metal and Air Conditioning Contractors' National Association

Project Management: An Overview to Effective Project Management

Prepared under the supervision of the SMACNA Business
Management Education Committee 1991-1992

Mark Watson, *Chairman*
Climate Engineers, Inc.
883 Shaver Road, N.E.
Cedar Rapids, IA 50265

Calvin Askeland
Johnson Contracting Co., Inc.
2750 Morton Drive
East Moline, IL 61244

Richard Dupre
New England Ventilation, Inc.
514 Main Street
Tewksbury, MA 01876

Judy Sandler
SMACNA of Long Island, Inc.
315 Walt Whitman Road, #314
Huntington Station, L.I., NY 11746

Roger Phelps
Barnes & Dodge, Inc.
316 Shawnee Avenue
Kansas City, KS 66105

Keith Wilson
Miller Metal Co., Inc.
4538 McLeod Road, N.E.
Albuquerque, NM 87109

Jack Hughes
Williard, Inc.
375 Highland Avenue
Jenkintown, PA 19046

Steve Bunting
Schoppe Co., Inc.
352 Van Buren Avenue
Salt Lake City, UT 84115

Joan Dennington
Peach State Metals, Inc.
1300 Fleetwood Dr., SE
Atlanta, GA 30316

Thomas Roth
james e. roth, inc.
9043 Marshall Road
Mars, PA 16046

Robert Daugherty, Staff
SMACNA, Inc.
4201 Lafayette Center Drive
Chantilly, VA 22021-1209

In cooperation with:
Mark A. Smith

EI ERNST & YOUNG

Ernst & Young Construction Industry Services

SMACNA and its authors and editors have applied diligence and judgment in locating and using reliable sources for the information published herein. However, no guarantee or warranty can be given, and all responsibility and liability for loss or damage are hereby disclaimed by the association, authors, and editors with respect to the accuracy and correctness of the information contained herein.

© Copyright 1991
Sheet Metal and Air Conditioning Contractors National Association

Printed in United States of America

Second Printing 1996

Table Of Contents

Basic Operating Factors	1
Job Location	2
Labor and Material Procurement	3
Equipment Usage	4
Labor, Materials, and Equipment Control	5
Subcontracting Problems	5
Supplying Management Personnel	6
Financing Requirements	7
Types Of Construction Contracts	7
Prejob Procedures	9
Staffing the Job	9
Picking Key Personnel	10
Company Policies	12
Establishing Cost Codes	12
Projecting Job Financial Requirements	14
Projecting the Progress Curve	15
Retained Percentages	16
Job Planning	16
Planning As a Management Tool	16
Using Bid to Plan	17
Daily Job Log	19
Claim Prevention	21
Cost Control	23
Record and Filing Systems	23
Cost Reports for Job Management	23
Cost Reports for General Management	25
Cost Reports for Future Work	26

Contract Closeout	27
--------------------------------	-----------

List Of Exhibits

Exhibit A Scheduled Labor Hours	10
Exhibit B Position Description for Project Manager	11
Exhibit C Checklist for Standard Cost Coding	13
Exhibit D Forecast of Cash Requirements	14
Exhibit E Direct Cost Incurrence	15
Exhibit F Scope of Work Checklist	18
Exhibit G Contract Controls Checklist	19
Exhibit H Daily/Weekly Project Report	20
Exhibit I Weekly Labor Cost Report	23

Preface

Project management is an all encompassing topic that embodies both the technical and managerial aspects of construction contracting. A generally accepted definition of project management is that it is the art of directing and coordinating human and material resources throughout the life of a project by using modern techniques to achieve predetermined objectives of scope, cost, time and quality.

Of course, most contractors realize that managing a project entails more than just ensuring the work is being performed in a timely and cost effective manner. This manual undertakes the task of setting guidelines that should be followed by a project manager in his attempt to ensure that a construction job is properly planned prior to the commencement of actual field work. Once a construction job is underway, a well-planned set of controls will greatly assist the project manager in completing the project on time and within budget.

This educational manual is separated into the following topical areas: basic operating factors that pertain directly to construction businesses, types of construction contracts, critical pre-job procedures, and the importance of proper job planning and cost control. The information presented herein will provide the project manager with a guide to the proper course of action that needs to be evaluated and implemented prior to the start of any field operations

PROJECT MANAGEMENT: AN OVERVIEW TO EFFECTIVE PROJECT MANAGEMENT

Basic Operating Factors

Once a construction contract has been awarded, the contractor's operations normally fall into four major phases of the contract cycle:

1. Procurement of necessary resources—labor, materials, supplies, and equipment,
2. Mobilization of resources to the construction site,
3. Management of resources to complete the work,
4. Demobilization of resources from the construction site.

The completion of these four phases for the physical work on any particular project constitutes a "job"—the basic unit of construction operations and the basic unit of project management for construction companies.

The extent to which any of the four major phases presents problems to any particular contractor on any one construction job depends on a great many factors. For example, the size, nature, and location of the job in relation to the other jobs which the contractor may have in progress will be important. So will the size and scope of the contractor's organization, its experience with the type of work involved, the necessary financing, and the extent to which specialized aspects of the work can be subcontracted.

The sheet metal contractor requires a system of management controls and information weighted toward emphasizing job management and contract cost controls. Of critical importance is the requirement for a set of controls designed to alert the project manager immediately when management attention is needed. The nature of the job, i.e., commercial, industrial, institutional, or utility, will greatly impact the way a project is organized and staffed.



Likewise, whether the project involves new construction versus renovation work will change the complexities in selecting management procedures.

In addition, there are certain factors apart from the mechanics of construction that may be significant in operations and hence in project management for operations. Some examples of such factors are:

1. Job location,
2. Labor and material procurement,
3. Equipment usage,
4. Labor, materials and equipment control,
5. Subcontracting problems,
6. Supplying management personnel,
7. Financing requirements.

Job Location

If a contractor confines his operations to one city or to a relatively small geographic area, problems arising from job location are usually at a minimum. He will be familiar with such issues as local union jurisdictions and practices, reputations of local suppliers and knowledgeable of the city permitting process.

However, when a contractor begins to take jobs farther from a central point, he often begins to incur liability for subsistence and travel time and sometimes for the cost of transporting his workers. In addition to these new costs, questions of payroll taxes, income tax withholding, and insurance on the additional payments arise. Also, the contractor faces increased costs in moving materials, supplies, and equipment to the job site.

In addition to the extra cost associated with moving into a new locale, a contractor should be especially concerned about securing proper management and workforce personnel for the job.

Many of the standard practices that appear to be routine in his city will have to be established at the new location, i.e. city permitting process, union jurisdictional rules, responsiveness of suppliers, etc.

The result is that the smaller prime contracts and a substantial share of the specialty subcontracts are awarded to local contractors. This happens because the size of the job does not warrant the added expense incurred by contractors with widely scattered jobs. The larger the job, the more likely a large, well-organized, and well-financed firm can handle it. By the same token, when small firms start to branch out and seek work farther from their center of operations, there is a tendency, at least on the first such job, to overlook the problems created by distance in determining the amount of their bids.

Labor and Material Procurement

The smaller and simpler a job is, the fewer requirements involved in the procurement of labor and materials. The logistics of supply is complicated by quantity and variety as well as by distance. Thus in a simple job, most, if not all, of the labor and materials will be available locally, and any savings in price which might be made through purchases from distant sources must be weighted against the readiness of local suppliers to serve and the delays and transportation costs inherent in distance. However, as jobs become more complicated, so do the procurement problems and the controls necessary to control these problems.

For many projects, the sheet metal contractor will purchase most, if not all, of the materials and products from a national manufacturer. Although the purchasing may be accomplished through a local supplier or representative, the shipment of material and products may originate from a distant location. In these cases, the project manager must keep a constant watch on procurement schedules to ensure proper delivery time to the job.

Many jobs have space limitations that drive the procurement decisions. For example, a multi-story building may require that the material be procured, packaged and transported to the job based on the specific floor number and exact location of a room on the floor. Lead time must be considered in purchasing products which must be fabricated for the job. For example, grilles, registers, diffusers, fans, and VAV boxes must often be built to order, and they must be ordered in advance (and followed through with expediting effort) so that they will be ready when needed.



Equipment Usage

Equipment usage for a sheet metal contractor falls into two distinct operations: fabrication shop and job site. The contractor's shop operation requires the greatest amount of equipment usage because of the day-to-day needs of supplying on-going projects with fabricated duct work. Shop operations, i.e. shearing, notching, bending, ductliner application, requires a well organized layout of the shop floor.

Control of the shop facility differs significantly from job site management in that the shop will have a near continuous flow of work, whereas each job site will have differing equipment needs. Because of the close interaction between the shop and field, a general superintendent must ensure that information is received from the field on a timely basis to enable accurate production and erection schedules.

The extent to which job site operations of a contractor require the use of equipment depends largely on the type of work being done, and the extent to which those parts of the work requiring special equipment can be subcontracted.

To own construction equipment usually requires a great deal of capital. If a contractor owns equipment, he must be constantly alert to avoid having all his working capital represented by idle or worn-out equipment.

Many contractors have found it more economical to rent or lease whatever equipment they need rather than tie up the funds required to own it. Equipment owners must constantly be ready to decide when it is more economical to dispose of any particular item than to keep it in repair.

In addition, the project manager should make a close evaluation as to whether it is more economical to use a particular type of equipment versus performing the work manually. For example, if it costs more to tie up a crane the entire day to distribute materials between floors as compared to manually moving the materials from one floor to the next, the latter would be the economical choice.

The type of equipment needed is an operational question. Whether to provide it by ownership, rental, or subcontracting is a management question that can be answered intelligently only

on the basis of facts that project management is called upon to supply.

Labor, Materials and Equipment Control

Materials are subject to two kinds of control—physical and financial. The physical control is, in large measure, an operational requirement which must be reflected in the accounts only to the extent necessary to keep management advised as to the quantity on hand. Management, however, is continually called upon to make financial decisions based on these questions: (1) Do we have it or must we buy it? (2) If we have to buy it, how much will it cost?

Labor and equipment are the two most important variables in construction costs. To control their physical application it is necessary to know from day to day how much work is being accomplished in relation to the amount of labor and equipment being used. The tool for doing this is "unit costing"—or cost accounting.

It is not hard to see that the larger and more complicated the job, the greater is the volume of accounting needed to control labor, materials, and equipment costs.

However, there is one important exception. If a large proportion of the work is subcontracted, as in large commercial building projects, the problems of controlling labor, materials, and equipment are considerably lessened.

However, as pointed out in the discussion of subcontracting, this procedure merely exchanges one set of operational and accounting problems for another.

Subcontracting Problems

Although the sheet metal contractor normally does not subcontract out much of its work, it is important to realize the contractual relationship between a prime and subcontractor.

From the viewpoint of the prime contractor, it is often good business on a large contract to spread the risk, financing, and operational problems by subcontracting certain portions of the work. From the viewpoint of the subcontractor, his problems are the same in both operations and accounting, as those of the



prime contractor on those portions of the work not being subcontracted.

Nevertheless, the prime contractor is almost always responsible to the owner for any failure of the subcontractor either to deliver the work he has contracted to perform or to pay his labor and material bills. For this reason the prime contractor must, to some extent, supervise not only the physical work of the subcontractor but also watch the latter's financial condition.

The subcontractor who, in turn, subcontracts a portion of his work is, in most respects, in the same position on the subcontracted work as a prime contractor. The main difference is that he is responsible to the prime contractor instead of to the owner. Both prime contractors and subcontractors must, of course, be alert to ensure that their contracts provide for payment and their operations and accounting controlled so that they receive payment for work actually done and materials actually supplied.

Supplying Management Personnel

Job management is essentially an operational function. In other words, the first function of job management, regardless of profit, is to get the work done. In both theory and practice everything else is secondary. If a profit is to be realized, the most efficient use of labor, materials, and equipment is required, and this requirement cannot be fulfilled unless management provides adequate supervision and planning.

The difficulties of adequate planning and supervision is compounded for a sheet metal contractor due to the separate operations of the fabrication shop and job site. In most cases, the contractor will be organized in such a way that the field and shop will report in a fashion to a project manager. His overall responsibility will be to ensure that both operations function smoothly and effectively. The shop foreman will be responsible for the flow of work through the shop facility as well as coordinating deliveries to the various job sites. Likewise, the project manager will control field operations by using appropriate schedule and cost information as well as coordinating the approvals of shop drawings.

The need for additional or better job management can be detected in a number of ways. Failure to meet time schedules, or the presence on the job of idle employees and equipment is a

sure sign. Also an experienced project superintendent should observe methods and procedures. None of these, however, reveals the inadequacies in job management so promptly as the scrutiny of job costs which have been carefully kept and promptly rendered.

Financing Requirements

The lifeblood of a construction job, as in any other business undertaking, is money. Progress payments are an established method of financing and it is a rare contractor whose working capital position is so strong that he can be indifferent to them. In fact, through such devices as advances for mobilization, unbalancing of bid and payment schedules, and generous estimates of completion, many contractors not only offset the customary retained percentage but actually recover their initial investments early in the job and continue it entirely on the funds received through progress payments.

However that may be, prime contractors require accounting statements from subcontractors as the basis for payment regardless of whether the contract is lump sum, unit price, time-and-material, or cost-plus. Regardless of the type of contract, the accounting records must furnish the basis for billings to the prime contractor. In contracts involving direct reimbursement for cost, complete and accurate accounting for expenditures is, of course, vital.

If financing is done through banks, there is no substitute for adequate financial statements in securing maximum financing. Bonding companies rely heavily on the financial position of the company as a whole and of individual jobs in determining bonding capacity.

Types of Construction Contracts

It is common to describe construction contracts by the method of payment they provide. When so classified, they fall into three groups.

- A. In the first group are found those contracts in which the contractor agrees to do certain specified things for an agreed price. In this group are lump sum and unit price contracts.

- B. In the second group are those contracts in which the contractor is reimbursed for his costs and receives a fee for his services. In this group are the cost-plus-a-percentage-of-cost, cost-plus-fixed-fee, and force account contracts.
- C. In the third group are those contracts which combine elements of the first and second groups.

Lump sum and unit price jobs will tend to involve greater emphasis on cost accounting and unit costs. Of course, sometimes the jobs are small enough and closely enough supervised to maintain a minimal amount of cost records. On such jobs, the cost records will tend to be only what the contractor needs to give him estimating data. On larger jobs, these types of contracts will require substantially more controls that enable the project manager to save on job costs by pointing quickly to the operations where more or better supervision is needed.

Cost-plus contracts usually require detailed emphasis on the documentation of costs and expenditures for materials, supplies, labor, and equipment. The contract should specifically state which costs are directly reimbursable versus costs that are considered part of overhead expenses. It is customary to find an agreed upon percentage markup for overhead expenses not incurred at the job site. Unless these types of contracts are written with exceptional care, the project manager is faced with innumerable problems of interpretation with the general contractor or owners representative.

Time and material contracts are much less demanding. Usually they involve smaller jobs and the principal concern is to see that all time paid by the contractor is billed to the client, and that all materials withdrawn from stock or purchased directly are charged to the job. In this type of work, it is common practice to add a fixed percentage to the billing for overhead and profit. Otherwise, it is necessary to increase the prices charged for labor and material to cover those items.

Each group of contracts has its own peculiar accounting requirements in addition to the general requirements which are common to all. Lack of understanding of the contract and failure to perform a careful review of its contents are major shortcomings that often prevent the contractor from making a responsible assessment of the risks involved.

For example, does the contract contain a "Changes" clause? Does it establish the right of the contractor to collect for additional costs under changed conditions? Is there a "Termination for Convenience" clause which may preclude the contractor from collecting lost profits? Are there exculpate clauses, e.g., no damage for delay. What are the notification requirements and procedures? What items are incorporated by reference in the contract? All of these factors should be matters of concern and careful review by the contractor during bidding or negotiations stage, and after the contract is received for signing.

Pre-Job Procedures

Staffing the Job

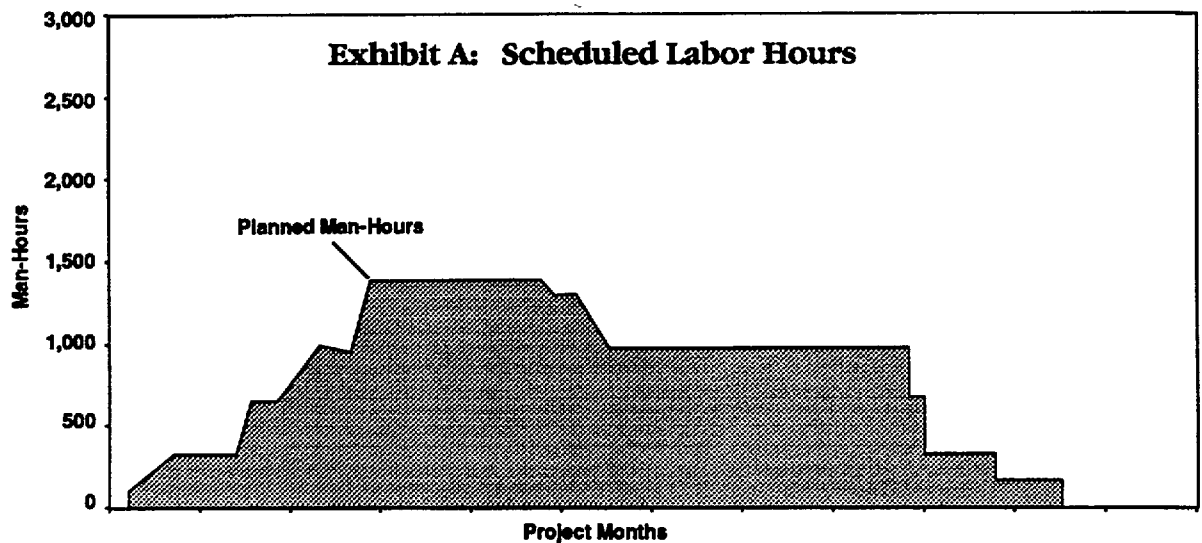
Regardless of the size of the contracting firm or the size of the job, somebody has to do the work. An individual contractor doing only one job at a time may put his tools in the back of his pickup truck, call for his helper, and go do the job himself. A contractor who has several small jobs going at one time might send out a journeyman on each job and occasionally call at the job to supervise the work. On larger jobs the contractor himself may act as foreman or superintendent and have journeymen and helpers working directly under him, or he might employ a foreman or superintendent and confine his own jobsite activities to general supervision.

At the other end of the scale, the job might be a multimillion-dollar project operated by a joint venture employing a project manager, a general superintendent, a project engineer, a project office manager, and a full staff of craft or area superintendents, engineers, foremen, journeymen, accountants, clerical personnel, and laborers. On such jobs the number of people on the payroll may run into the hundreds or even the thousands.

Whatever the size or the nature of the job, project management must decide, before the job starts, how many people will be required to do the work and who the key people, at least, will be. Normally, a sheetmetal contractor can estimate manpower needs by developing a manpower loading curve based on each shop drawing.

Exhibit A illustrates a typical manpower loading curve that is based on the planned man hours required for scheduled work activities over a eleven-month period. The manpower levels are

estimated by reviewing the shop drawings to determine the number of craftsman needed for each activity that corresponds with the project schedule.



Picking Key Personnel

Adequate project supervision and planning are essential to ensure that the job will be accomplished on time and within budget. The project manager selected for each job will be the most critical factor in setting the correct direction for a successful job.

Selecting a project manager for a particular job normally depends on that persons present workload and past experiences with similar types of jobs. **Exhibit B** lists a typical job description and duties of a project manager.

Exhibit B
Position Description for Project Manager

Title: Project Manager

Reports to: President

I. Overall Accountability:

Accountable for the planning, schedule, general coordination and cost control of jobsite sheet metal trade activities for assigned projects.

II. Nature and Scope:

A. Organization:

Reports to and is directly responsible to the President.

B. Operational:

1. Supervises the Job Foreman for assigned projects.
2. Forecasts, establishes and coordinates jobsite.
3. Secures and approves foreman status and notifies accounting of rate changes.
4. Review construction budgets, productivity levels at the site, forecast completion costs, and justifies costs variances.
5. Consults with estimating on productivity rates for various costs categories of work.
6. Initiates sales contacts and secures work on a firm bid or negotiated guaranteed maximum price (GMP) basis.
7. Makes purchases within established budgets and approves payment of invoices through an established approval system.
8. Evaluates changes and processes change order requests.
9. Participate in a value engineering concept for shop drawing preparation.
10. Shop Drawings and Submittals:
 - a. Schedule shop drawings and mechanical trade coordination drawings.
 - b. Approves sheet metal submittals and submits items for final review and approval by the professional consultants for the project.
11. Schedules fabrication, i.e., duct, fittings, special fabrication.
12. Coordinate between other trade contractors on site.
13. Coordinate subcontractors.

III. Activities Essential for Attaining Accountability:

- A. Maintain a cost information system for field activities.
- B. Maintains all necessary information in a current status to properly administer and coordinate the project.
- C. Rents special tools.
- D. Controls and schedules the work, a workforce, and materials for optimum productivity.
- E. Record activities of subcontractors.

IV. Standards of Performance:

- A. Timeliness of reviewing and identifying cost problems within a project.
- B. Reliability (high quality and response to customers needs) of services provided.
- C. Ability to set priorities.



Company Policies

Just as each job offers its own construction problems, so each has its own staffing problems. It is rare that a growing organization can fill all important jobs from within its ranks. Likewise it is a rare organization that will not find new staffing problems arising from shifts in company policy and job conditions. Because contractors primarily sell their knowledge and experience, and that of their organization, staffing problems are never ending. Therefore, new people are always entering the organization, bringing with them the standards of their former jobs. Each company must necessarily have standards of its own. It is not practical to hold employees to a standard unless they are aware of standard work rules.

As soon as a contractor reaches the size where authority to make administrative decisions must be delegated to others, a manual of policy and procedure, and a program for making its contents known to key employees, are vital. One of the most important of the pre-job procedures is to make sure that the people who will be assigned to the job:

1. Are properly briefed on that job;
2. Are supplied with the proper manuals, and
3. Know the contents and how the accounting controls and policy information are to be used.

Early in the mobilization period, a detailed written description of the project organization should be developed, with specific authority and responsibilities of individuals' positions spelled out. Of particular importance are defined responsibilities and written procedures covering methods, authority and responsibilities for processing and approval of change orders, for purchasing and receiving, and for cost-accounting functions.

Establishing Cost Codes

To ensure accurate accounting of job costs, it is necessary to determine the cost accounts that will be used and the symbols that will be used to designate those accounts. This procedure must be established before the job starts; otherwise, the expense of keeping job costs will probably escalate due to increased manhours needed to recreate/track job costs.

Most effective cost codes are set up to follow the bid and to enable the compilation of cost figures on the same units as those used in preparing the initial bid. Only in this way can the effectiveness of the bidding methods be checked against actual operations. In addition, where progress billings are based on percentage of completion, costs kept by bid items are helpful in establishing the percentages.

If the type of work a contractor does is fairly well standardized, it is usually possible to prepare a standard estimating checklist that can be the basis of the cost code. **Exhibit C** is the typical checklist used by a sheet metal contractor. In addition, it is common to see each cost account broken down into its various cost components as follows:

1. Labor
2. Incorporated Materials
3. Equipment rentals
4. Shop Fabrication
5. Subcontracts
6. Distributed overhead

Exhibit C
Checklist for Standard Cost Coding

<u>Job Code</u>	<u>Description</u>	<u>Job Code</u>	<u>Description</u>
01	Duct	15	Round Fittings
02	Fittings	16	Hoods
03	Lining	17	Sleeves
04	Housing	18	Miscellaneous Materials
05	Hangars and Bracing	19	Drayages
06	Painting	20	Hoisting and Unloading
07	Access Doors	21	Supervision
08	Metal Vents	22	Balancing
09	Boiler Breeching	23	Bond
10	Dampers	24	Equipment
11	Louvers	25	Subcontracts
12	Penthouses	26	Rental and Small Tools
13	Curbs	27	Special Duct and Fittings
14	Round	28	Misc. Items and Job Extras



Projecting Job Financial Requirements

Every time a new job is undertaken, it is necessary to provide financing to operate it. In order to have money on hand when it is needed, it is important that cash requirements be forecast as soon as possible. This is a simple matter of spreading the estimated costs to the various weeks in which they are expected to occur, and it can usually be done by the estimator as soon as his bid is complete. The spread is usually weekly because the standard pay period is weekly. The estimator should supply this breakdown on any bid that may result in a contract. Thus, on a job estimated for completion in twenty-one weeks the breakdown might be similar to the one shown in **Exhibit D**.

Exhibit D
Forecast of Cash Requirements

Week	Direct Labor	Incorp. Materials	Equip. Rental	Shop Fabricatn	Sub-Contracts	Distrib. Overhead	Estimated Progress Billings	Cumulative Est. Cash Investment In Job
1	\$ 500					\$ 750		\$ 1,250
2	750					1,250		3,250
3	1,000					1,000		5,250
4	1,250					800		7,300
5	2,000	\$ 2,000	\$ 1,500	\$ 15,000	\$ 1,000	800	\$(29,300)	300
6	2,000					700		3,00
7	3,000	14,000	4,500		1,250	700		26,450
8	3,000					700		30,150
9	3,000	4,000	5,000	20,000	1,500	700	(63,400)	950
10	3,500					600		5,050
11	4,000	16,000	5,000		1,750	600		32,400
12	4,000					600		37,000
13	2,000	10,000	4,000	20,000	1,500	600	(83,400)	(8,300)
14	1,500					500		(6,300)
15	1,000		2,000			500		(2,800)
16	500				500	400		(1,400)
17				17,000		300		15,900
18							(21,900)	(6,000)
19								
20								
21				8,000			(22,000)	(20,000)
	\$33,000	\$46,000	\$22,000	\$80,000	\$7,500	\$11,500	\$(220,000)	\$0

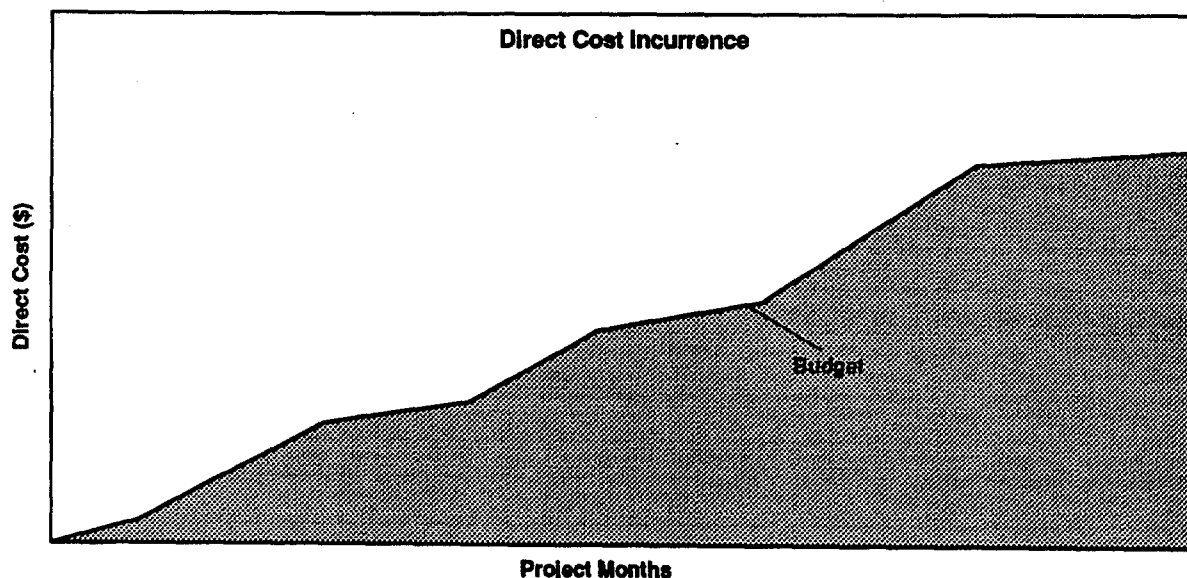
Projecting the Progress Curve

One of the often neglected pre-job procedures is to project the progress of the job in terms of percentages of completion. Normally this is done either by the estimator or by the project manager. However, before any substantial amount of financial or personnel planning can be done, it is necessary to have this information.

It is the usual procedure to base such curves on estimates of costs as they will be incurred, and not upon the estimated cash expenditures. Thus payrolls, including all related payroll taxes and insurance, are accrued at the end of the payroll week; purchases of materials, supplies, small tools and shop fabricated work are accrued when they are scheduled for delivery on the job; equipment rentals (or prorated shares of equipment ownership expenses) are accrued at the end of each week based on estimated equipment requirements; other estimated costs are accrued at the end of the week in which they are expected to be incurred. A progress curve projected on this basis should approximate very closely the percentage of completion curve customarily prepared by the engineers.

Such a curve usually takes the form of an "S". In other words it starts slowly, rises sharply as the job reaches full production, and then tapers off as the job approaches completion. *Exhibit E* illustrates a typical "S" curve of how direct costs are incurred over time.

Exhibit E Direct Cost Incurrence



Retained Percentages

It is customary for progress payments to be made either monthly or at certain agreed stages of completion. It is also customary for the prime contractor to withhold an agreed percentage (usually 5%) of each payment. To forecast financial requirements, it is necessary to forecast the progress billings and the dates of their collection. It is equally important to forecast the date of collecting retained percentages. Many subcontractors find this problem particularly acute because contractors generally require subcontractors to wait for their retentions until the prime contractor receives his at the conclusion of the entire job.

Such a situation must be taken into account in the pre-job planning. Often the problem can be avoided by including in the subcontract bid, as a separate bid item, interest on any portion of the subcontractors retained percentage that remains unpaid after completion of the subcontractors work. If the prime contract contains language affecting the percentages to be held back from subcontractors as well as the prime contractor, those provisions must be taken into account in forecasting the cash to be received by the subcontractor on progress billings.

Job Planning

Planning as a Management Tool

There is one aspect of pre-job planning that deserves special treatment. Modern construction management involves a sophisticated integration of design and construction methods. Any proper pre-job plans for project management must include plans for providing the necessary budgetary controls, cost controls, quality controls, and time controls needed by top management personnel. These controls are needed to manage the jobs so that they can be completed on time and at a profit.

However, it is equally important to recognize that it is a costly mistake to provide for records that management cannot (or will not) use. For example, critical path method (CPM) may produce excellent results in jobs sufficiently complicated to justify them and where the savings through proper management can justify their cost. On other jobs, they may cost more than they are worth. The function of pre-job planning is to select the controls, and the accounting methods needed to achieve them, with due consideration for the nature of the job and the needs of the people who will manage it.

Using Bid to Plan

The starting point for job planning is the bid. By the time it is complete, the estimator will have built the entire job in his mind. In so doing he will have analyzed the job by operations and will have determined when each operation is to start and finish in relation to the others. The estimator will also have determined how much each operation is to require in terms of worker-hours, fabrication hours, and working days. Each of these factors is expressed in both time and money, and the relationship and timing among the various work items will have been determined.

When the job is awarded, the person who is to manage the job will review each aspect of the bid, refining it where needed. The work items to be subcontracted will have been analyzed and examined, and, it is hoped, all gaps and overlaps in the work to be subcontracted will have been eliminated. In its completed form the bid is, for all practical purposes, a budget for the job. **Exhibit F** is a typical checklist that a sheet metal contractor will use to determine the extent of the job's scope of work.

At this time the cost coding will be established, and each work item and the cost breakdowns within the work items will be assigned the account numbers that are to be used in the cost accounting on the job. **Exhibit G** provides a checklist of questions that the project manager should use to ensure that proper management controls are in place prior to commencing field operations.



Exhibit F
Scope of work Checklist

Project Name _____

Project No. _____

	Included	Excluded	N/A	Furnish Only	Install Only	Composite
Access Doors						
As-Builts						
Air Filters						
Duct Liner						
Duct Work						
Energy Calculations						
Equipment						
Fire Dampers						
Flashing						
Flues						
Louvers						
Permits						
Shop Drawings						
Smoke Dampers						
Bases and Sleepers						
Clean Up						
Concrete Curbs/Pads						
Cutting and Patching						
Demolition						
Lintels						
Roof Curbs						
Roofing						
Scaffolds						
Structural Supports						
Control Dampers						
Control Wiring						
Smoke Detectors						
Temperature Controls						
Timers						
Crane/Rigging						
Matrial Hoists						
Scaffolds						
Excavate/Backfill						
Insulation						
Painting						
Site Utilities						
Structural Calculations						
Survey/Repair of Existing Equipment						
Condensate Traps/Drains						
Gas Piping						
Disconnects						
Electric Conduit						
Electric Startrs						
Line Voltage Wiring						

Exhibit G

Contract Controls Checklist

1. Do we have the information necessary to submit our progress billings promptly and accurately?
2. Do our permanent records provide complete and accurate support for our progress billings?
3. Are we able to support our claims for extra work done for the client or for others by written orders signed by an authorized representative of the person for whom the work was done?
4. Do we know what we bought, how much it cost, and whether we got it?
5. Are our routines for purchasing, receiving, vouchering, and disbursing arranged so that we can take all discounts, pay bills promptly and accurately enough to keep our credit good, and still avoid duplications and overpayments?
6. Can we tell what we did with the things we bought?
7. Do our timekeeping and payroll procedures let us pay our employees promptly and accurately and in accordance with union rules, wage and hour rules (where applicable), and any special rules in the contract (such as the Copeland Act, the Davis-Bacon Act, and various state and local statutes)?
8. Are our payroll records sufficient for all federal and state regulations as well as for payroll and withholding tax purposes?
9. Can we supply, from the records, the information needed by management?
10. Can we supply our bank and our bonding company the detail they want concerning each job as well as our overall operation?

Daily Job Log

Once a job is underway, one of the most critical pieces of documentation is the daily job log. A sample form is shown in **Exhibit H**.

The log is completed on a daily basis by the job foreman. It is organized in such a way to capture valuable information regarding project conditions and potential problems. Completion of the diary is essential to document delays, changes in schedule, or other problems which may result in a contract claim.



Exhibit H Daily/Weekly Project Report

Date: _____
Project Name and Number _____ Crew Size _____
Job Schedule On Time _____ Late by _____ Extended _____ Ahead _____

Weather Conditions: Rain ☐ Snow ☐ Fair ☐ Outside Temperature _____ Building Temperature _____
Site Conditions _____

(If yes, give brief explanation)

A. Job-site Meeting	Yes ☐	No ☐	_____
B. Problems with Sub-trades	Yes ☐	No ☐	_____
C. Field Information Required	Yes ☐	No ☐	_____
D. Delayed by Other Trades	Yes ☐	No ☐	_____
E. Delayed by Weather	Yes ☐	No ☐	_____
F. Delayed by Change Notices	Yes ☐	No ☐	_____
G. Material/Equipment Delays	Yes ☐	No ☐	_____
H. Equipment Arrived Site Not Ready	Yes ☐	No ☐	_____
I. Damage/Theft/Accident or Injury	Yes ☐	No ☐	_____

Problems: Were you prevented from doing any work on any part of the project due to any circumstances beyond your control? Were you required to perform work outside the requirements of the contract? Did you perform work for the G. C., owner, any subcontractor or supplier that should be backcharged? Special Occurrences? Other Anticipated Problems? Controversial Issues? Site Instructions? If yes to any of these questions, explain.

Area of Work and Progress

Sub Trade Report

Claim Prevention

The periods of initial planning, and the periods before and immediately following award of the contract, are extremely important to preventing disputed claim situations altogether. They also represent the ideal time to provide for systematic collection and retention of information needed to manage the project or to support a future claim, if needed.

The best opportunity to collect and document evidence for a claim is during the actual occurrence of the problems. Very few contractors seem to make use of methods available, for many reasons:

1. Failure on the part of the contractor to recognize the problems, or its magnitude on other activities.
2. Failure to provide enough time for the project manager or office administrative personnel to track and account for activities and costs.
3. Failure to recognize the need for cost accounting skills, systems, or controls at the job site.
4. An overriding emphasis on getting the job done first and settling cost problems later.

Several reasonable methods and techniques are available for tracking and documenting costs of disputed work items during construction. Basic methods, such as the daily log, submittal logs, and material receiving logs can be valuable sources of information if they are properly maintained and directed to specific problems.

Most important during construction is the ability to recognize situations involving work outside the contract and to isolate the work from normal project activities so that costs can be tracked separately. A well trained project manager with adequate staff and a flexible chart of accounts and cost reporting system are essential so that equipment and material costs can be recorded and allocated appropriately.



Cost Control

Record and Filing Systems

Standard record and filing systems should be established and maintained for each contract, along with standard reporting procedures to provide required information. Good project management requires systematic collection, preservation and retrieval of at least the following:

1. Request for quotation bid, specifications, test reports, and other documents, provided by the prime contractor or owner.
2. The contract and all amendments.
3. Meeting notes and correspondence with the prime contractor and architect/engineer.
4. Original estimate and estimate workpapers plus any revisions.
5. Project schedule and budgets, including all changes.
6. Progress reports and photographs of construction progress and job conditions.

Cost Reports for Job Management

Probably the most important of all the cost reports is the weekly labor cost report. Through it, job management can keep a check on the most elusive element in the whole field of construction costs. If this one report is received on a timely basis, and is accurate, there is no better guide for the application of management control. An experienced construction manager can compare the labor cost to date, total estimated labor cost, and physical work still to be done on any particular work item, and tell with great accuracy how well that part of the job is progressing. In a company with a number of smaller jobs, or on a large job with numerous work items, it is on this basis that the person in charge decides where to spend his own time and that of his supervisory staff.

Similar reports may be made on materials consumed or placed and on equipment time. Both serve a purpose similar to that of the labor cost report. When time and staff permit, a weekly cost summary (*Exhibit I*) can be extremely useful. Otherwise, the labor summary is usually the most effective tool in helping job management direct its efforts most effectively.

Exhibit I Weekly Labor Cost Report

Project: Commercial Office Guiding
Week Ending: October 22, 1991

Project No.: 1260
Prepared By: Smith

Cost Code	Direct Labor Cost			Labor Unit Cost			To Date		Projected	
	Budget	Prior Week	To Date	Budget	Prior Week	To Date	Saving	Loss	Saving	Loss
240.01	4,680	185	3,243	4.50	4.73	4.80		203		312
240.05	5,796	249	2,519	6.30	6.00	6.06	100		221	
240.07	16,632	90	4,473	6.00	6.92	6.78		515		2,162
240.08	3,200	76	381	6.30	6.35	6.35		3		25
240.51	32,000	143	12,477	0.25	0.25	0.23	1,069		2,560	
240.91	54,000	17	1,288	0.03	0.03	0.024	321		1,080	

Job management often needs a detailed analysis of cost on a particular work item. If the job cost ledger has been kept, the information should be available there. If the weekly cost summary has been kept, the answer would appear in that report.

If neither has been kept, then it may be necessary to extract the needed information from such basic data as time cards and purchase invoices.

Such information might be needed for a number of purposes. For example, price negotiations for a change order may be in progress; daily cost reports may have indicated differences between the job estimate and the actual operating results that require further analysis; or current results on this job may be needed for a guide in bidding new work or justifying a claim in negotiation or an estimate for financing purposes. Whether any or all of these possibilities justify the cost of preparing a job cost ledger is, of course, a problem peculiar to each contractor.

Cumulative cost figures, by individual work items and for the entire job, are meaningful to job management because they may be compared to the total contract price to show how much money is left in the contract and in the budget for each work item to complete the work. A cumulative form for labor or equipment provides such information. This information, combined with unit costs and elapsed time figures, indicates to job management what it must do in order to earn the estimated profit on the job.



For example, if unit costs are below the estimate, but time is running short, some overtime to bring the work up to schedule may be justified. On the other hand, if unit costs are high and the job is lagging it means more and better supervision is needed quickly to bring the troublesome work item back into line to prevent loss. It may mean that work is being done that should be compensated as an "extra" and, if so, the sooner the extra is claimed, the better. Usually it means that either the work is not being done efficiently, or the job estimate is wrong. In either case, prompt attention from job management is required.

Cost Reports for General Management

There are two indicators of satisfactory job progresstime and money. Up to a certain point the faster the work progresses, the less it costs. This is true for several reasons.

Rapid progress means planning has been effective, and there are few time-consuming errors to correct. Also, the faster the job progresses, the lower the amount of overhead that each unit of production has to carry.

Beyond a certain rate, however, each unit of production increases in cost. Overtime, inadequate space, and mistakes resulting from speed and pressure all contribute to this loss of efficiency. To determine how closely any particular job can or should be run to this point of diminishing returns, and to see that it keeps running at the predetermined rate, is the job of general management. One of the tools which general management uses to accomplish this purpose is the job progress report. This form shows one weeks progress on one job. It breaks the job down into work items, and compares the key variables (labor and equipment costs) on each work item with the totals estimated for that time, the total labor or equipment cost of the work accomplished for the week and for the job to date, and the unit costs according to the estimate and according to the actual operations. These data, when combined with the more complete figures on the monthly statement, give most key executives the current money figures they need.

But money figures alone rarely tell the whole story. To supplement them it is usually necessary to have an additional weekly report that provides the overall status of the job. This report covers weather, work force, special job conditions, time progress, and financial forecast. It completes the analysis of job

operations already developed from the financial statements and the weekly cost reports.

Cost Reports for Future Work

One of the most commonly discussed and least understood uses of cost reports is in bidding other work. It is easy to think that, having done a certain operation before under a variety of circumstances and having kept accurate cost records on it, the unit costs might be helpful in bidding.

Actually, this practice is dangerous because it tends to lead to bidding at a fixed price per unit of work. The risk in using cost figures in bidding lies in the ease with which an estimator may assume that the same kind of work will cost the same on all jobs. If unit prices are available from similar jobs, it is easy for an estimator, working against a bid-opening deadline, to use them without considering the individual problems of the job being bid. On the other hand, if averages may be safely used, good unit cost figures can make it possible for an estimator to prepare more bids and do a faster and better job.

Probably the safest way to use cost figures in bidding is as a check on the estimators thinking. If he is estimating new work and the difference between the bid and the former actual performance is substantial, then he should find the reasons for the difference. If he is analyzing operations to find the reasons for a difference between unit costs estimated and unit costs actually incurred on a current job, deviations in the unit cost of the same type of work on other jobs may provide the answers.

The most useful application of cost figures to bidding is the analysis of each job after it is complete to account for differences between the estimate and the actual result. In this way errors in the methods used in preparing bid estimates can be found and corrected. Equally important, methods of operation assumed by the estimator can be compared with those followed on the job, and the results of a study can be considered on the next job involving similar work.



Contract Closeout

To achieve a timely and effective job completion the project manager should devote as much effort to plan and control the project closeout as with any other major phase of the work. Extending the closeout date of a project will not only delay the contractors final payment, but will usually result in a disgruntled client and the risk of possible contract disputes.

Construction contracts generally provide that acceptance of the contractors performance is subject to the formal approval of the architect-engineer and/or the owner. When the sheet metal contractor is nearing completion of the scope of work, he will advise the owners representative when substantial completion is expected to be achieved. An inspection and walk-through is held and a list of deficiencies, called a punch list, is compiled. Once substantial completion is attained, most contracts entitle the contractor to be paid up to a specified percentage of the total contract amount, normally 95 percent, less any punch list items. Once the deficient items are corrected, final payment is due to the contractor normally within 30 days.

Acceptance of the work and final payment constitutes a waiver of the owner's rights for damages due to defects in the contractor's work if no claim is made within a reasonable period of time. Most contracts require that the contractor repair all defects that result during a specified warranty period. One year is a commonly specified warranty period that normally commences after the date of final acceptance.

Many project managers begin to lose their enthusiasm for a job once it nears final closeout. They begin to devote more time to other on-going projects or developing plans for the next job. This is a major mistake that must be avoided. Project managers must remember that the time spent finishing the job will usually result in the greatest amount of benefits to the company. The last few days on a job will be the time that most general contractors and owners remember the willingness of the sheet metal contractor to finish the contract work on a timely basis. It is at such a time that the project manager must ensure that the goodwill built-up throughout the job will be remembered and aid in securing future contracts.